

CLAIMS

1. A display device comprising:

first electrodes classified into a plurality of groups;

second electrodes respectively provided so as to cross
5 said first electrodes;

a display panel comprising a plurality of capacitive
light emitting elements respectively provided at
intersections of said first electrodes and said second
electrodes; and

10 a drive circuit that applies a data pulse for
light-emitting the selected capacitive light emitting
element to the first electrodes in said plurality of groups
such that phase differences respectively occur between said
plurality of groups,

15 said drive circuit comprising

a recovering capacitive element,

an application circuit that discharges charges to said
first electrodes from said recovering capacitive element or
recovers the charges from said first electrodes in said
20 recovering capacitive element, to apply a driving pulse for
applying the data pulse to said first electrodes, and

a potential limiting circuit that limits the quantity
of the charges recovered in said recovering capacitive
element, to limit a potential of said recovering capacitive

element so as not to exceed a predetermined value.

2. A display device comprising:

first electrodes classified into a plurality of groups;

5 second electrodes respectively provided so as to cross
said first electrodes;

a display panel comprising a plurality of capacitive
light emitting elements respectively provided at
intersections of said first electrodes and said second
10 electrodes; and

a drive circuit that applies a data pulse for
light-emitting the selected capacitive light emitting
element to the first electrodes in said plurality of groups
such that phase differences respectively occur between the
15 plurality of groups,

said drive circuit comprising

an inductive element,

a recovering capacitive element,

an application circuit that discharges charges to said
20 first electrodes from said recovering capacitive element by
a resonance operation of a capacitance of said display panel
and said inductive element or recovers the charges in said
recovering capacitive element from said first electrodes
through said inductive element, to apply to said first node
25 a driving pulse for applying the data pulse to the first

electrodes in said plurality of groups, and

a potential limiting circuit that limits the quantity of the charges recovered in said recovering capacitive element, to limit a potential of said recovering capacitive
5 element so as not to exceed a predetermined value.

3. A display device comprising:

first electrodes classified into a plurality of groups;

second electrodes respectively provided so as to cross
10 said first electrodes;

a display panel comprising a plurality of capacitive light emitting elements respectively provided at intersections of said first electrodes and said second electrodes; and

15 a drive circuit that applies a data pulse for light-emitting the selected capacitive light emitting element to the first electrodes in said plurality of groups such that phase differences respectively occur between said plurality of groups,

20 said drive circuit comprising

a first power supply terminal receiving a first power supply voltage,

an inductive element,

a recovering capacitive element,

25 an application circuit that discharges charges from

said recovering capacitive element by a resonance operation of a capacitance of said display panel and said inductive element to raise a potential at a first node, connects said first node and said first power supply terminal to each other, 5 then disconnects said first node and said first power supply terminal from each other, and recovers the charges in said recovering capacitive element from said first node through said inductive element by said resonance operation to lower the potential at said first node, to apply to said first node 10 a driving pulse for applying the data pulse to the first electrodes in said plurality of groups, and

a potential limiting circuit that limits the quantity of the charges recovered in said recovering capacitive element, to limit a potential of said recovering capacitive 15 element so as not to exceed a predetermined value lower than said first power supply voltage.

4. The display device according to claim 3, wherein the inductive element is provided between said first 20 node and a second node,

said recovering capacitive element is connected to a third node,

said potential limiting circuit limits a potential at said third node, to limit the potential of said recovering 25 capacitive element so as not to exceed said predetermined

value,

said application circuit comprises

a first switching element provided between said first power supply terminal and said first node,

5 a second switching element provided between a ground terminal receiving a ground potential and said first node,

a third switching element provided between said second node and said third node, and

a fourth switching element provided between said second node and said third node, and

10 in an address time period during which said selected capacitive light emitting element in said display panel is to be light-emitted, the third switching element is turned on so that the charges are discharged into said first node from said recovering capacitive element through said
15 inductive element, the potential at said first node is raised, said third switching element is turned off and said first switching element is turned on so that the potential at said first node is raised to said first power supply voltage, and
20 said first switching element is turned off and said fourth switching element is turned on so that the charges are recovered in said recovering capacitive element from said first node through said inductive element so that the potential at said first node is lowered, thereby generating
25 said driving pulse.

5. The display device according to claim 3, wherein
said drive circuit further comprises first switching
circuits respectively provided in correspondence with said
5 first electrodes, and is operated such that
said first switching circuit is turned on so that the
charges are recovered and discharged between said first node
and said first electrode, and said first switching circuit
is turned off so that said corresponding first electrode is
10 set to the ground potential.

6. The display device according to claim 4, wherein
said potential limiting circuit comprises
a division circuit that divides a voltage between said
15 first power supply voltage and the ground potential to produce
a potential approximately equal to said predetermined value,
and
a second switching circuit connected between said third
node and said ground terminal and receiving the potential
20 produced by said division circuit as a control signal, and
turned on when the potential at said third node exceeds said
predetermined value.

7. The display device according to claim 4, wherein
25 said potential limiting circuit comprises

a second power supply terminal receiving a second power supply voltage approximately equal to said predetermined value, and

5 a second switching circuit connected between said third node and said ground terminal and receiving said second power supply voltage received by said second power supply terminal as a control signal, and turned on when the potential at said third node exceeds said predetermined value.

10 8. The display device according to claim 6, wherein said second switching circuit comprises

a unidirectional conductive element provided between said third node and a fourth node and causing a current to flow from said third node to said fourth node, and

15 a fifth switching element provided between said fourth node and said ground terminal, and having a control terminal receiving said control signal.

20 9. The display device according to claim 4, wherein said potential limiting circuit comprises

a unidirectional conductive element provided between said third node and said ground terminal and causing a current to flow from said third node to said ground terminal when the potential at said third node exceeds said predetermined
25 value.

10. The display device according to claim 9, wherein said unidirectional conductive element is a zener diode.

5 11. The display device according to claim 4, further comprising a charge pump circuit that produces a potential higher than the potential at said first node in order to turn said first switching element on.

10 12. The display device according to claim 11, wherein said charge pump circuit comprises a charging capacitive element provided between said first node and a fifth node,

15 a unidirectional conductive element provided between a third power supply terminal receiving a third power supply voltage and said fifth node and causing a current to flow from said second power supply terminal to said fifth node, and
20 a control signal output circuit that adds a potential at said fifth node to the potential at said first node, and outputting a potential obtained by the addition to said first switching element as a control signal.

13. The display device according to claim 3, wherein said predetermined value is more than one-second said first
25 power supply voltage and is not more than four-fifth said

first power supply voltage.

14. The display device according to claim 3, wherein
said phase difference is not less than 200 ns.

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15. The display device according to claim 3, further
comprising

a plurality of drive circuits,

said plurality of drive circuits being respectively
10 provided in correspondence with said plurality of groups, and

said plurality of drive circuits respectively applying
the data pulses for light-emitting the selected capacitive
light emitting element to said first electrodes in said
plurality of groups such that phase differences respectively
15 occur between said plurality of groups.

16. The display device according to claim 3, further
comprising

a number-of-times detector for detecting the number of
20 times of rise or the number of times of fall of the data pulse
applied to said first electrodes,

said drive circuit further comprising

a controller for calculating the ratio of said number
of times detected by said number-of-times detector to the
25 maximum number of times the data pulse can rise or the number

of times the data pulse can fall, lowering, when said ratio is more than a predetermined ratio value, the potential at said first node to a predetermined voltage value, and then controlling the operation of said application circuit such
5 that said first node is grounded.

17. The display device according to claim 16, further comprising

a converter for converting, in order to divide one field
10 into a plurality of sub-fields and discharge said capacitive light emitting element selected for each of the sub-fields to perform gray scale expression, image data corresponding to the one field into image data corresponding to the sub-field,

15 said number-of-times detector detecting said number of times for each of the sub-fields on the basis of the image data fed from said converter,

said controller calculating the ratio of said number of times obtained by said number-of-times detector to the
20 maximum number of times the data pulse in each of the sub-fields can rise or the maximum number of times the data pulse can fall, lowering, when said ratio is more than the predetermined ratio value, the potential at said first node to the predetermined voltage value, and then controlling the
25 operation of said application circuit such that said first

node is grounded.

18. The display device according to claim 16, wherein said predetermined ratio value is not less than 95 %.

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19. A method of driving a display device comprising first electrodes classified into a plurality of groups, second electrodes respectively provided so as to cross said first electrodes, and a display panel comprising a plurality of capacitive light emitting elements respectively provided at intersections of said first electrodes and said second electrodes, comprising the step of:

respectively applying a data pulse for light-emitting the selected capacitive light emitting element to the first electrodes in said plurality of groups such that phase differences respectively occur between said plurality of groups,

the step of applying the data pulse comprising the steps of

20 discharging charges from a recovering capacitive element by a resonance operation of a capacitance of said display panel and an inductive element to raise a potential at a first node, connecting said first node and a first power supply terminal to each other, then disconnecting said first node and said first power supply terminal from each other,

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and recovering the charges in said recovering capacitive element from said first node through said inductive element by said resonance operation to lower the potential at said first node, to apply to said first node a driving pulse for
5 applying the data pulse to the first electrodes in said plurality of groups, and

limiting the quantity of the charges recovered in said recovering capacitive element, to limit a potential of said recovering capacitive element so as not to exceed a
10 predetermined value lower than said first power supply voltage.

20. The method of driving the display device according to claim 19, further comprising the steps of

15 detecting the number of times of rise or the number of times of fall of the data pulse applied to said first electrodes, and

calculating the ratio of said detected number of times to the maximum number of times the data pulse can rise or the
20 number of times the data pulse can fall, lowering, when said ratio is more than a predetermined ratio value, the potential at said first node to a predetermined voltage value, and then controlling the operation of said application circuit such that said first node is grounded.

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21. The method of driving the display device according to claim 20, wherein said predetermined ratio value is not less than 95 %.

5 22. The method of driving the display device according to claim 19, wherein said predetermined value is more than one-second said first power supply voltage and is not more than four-fifth said first power supply voltage.